Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.9066

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2024) *12*(3), 58-65

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Effect of Sowing Methods and Row Spacing on Growth, Yield and Economics of Multicut Sorghum and Pearl Millet Hybrids

Arun Verma[1*], Priyanka Kumari[2] and Ravinder[3]

[1]M.Sc. Agronomy, [2]Assistant Professor, Agronomy, [3]Assistant Professor, Soil Science,
School of Agriculture, Abhilashi University, Mandi (Himachal Pradesh)

*Corresponding Author E-mail: rockstararunvermaak@gmail.com

Received: 26.02.2024 | Revised: 30.04.2024 | Accepted: 13.05.2024

ABSTRACT

A field experiment was conducted at the Research Farm of the School of Agriculture, Abhilashi University, Mandi (H.P.) during Kharif 2022 to study the effect of sowing methods and row spacing on yield and economics of multicut sorghum and pearl millet hybrids. The experiment was laid out in a randomized block design with three replications comprising nine treatments. The results of the study revealed that line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows resulted in better plant height (cm), shoot number (m^{-2}), dry matter accumulation (g m^{-2}) with the highest total green fodder (24.09 t ha^{-1}) and dry fodder yields (4.37 t ha^{-1}). Line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows realized the highest net returns of Rs. 30817 ha^{-1} with net returns per rupee invested of 1.05. Line sowing of pearl millet alone in 30 cm apart rows was found to be comparable with line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows, which was the next best treatment.

Keywords: *Sorghum, pearl millet, sowing methods, line sowing, broadcast sowing.*

INTRODUCTION

Livestock plays an important role in the rural economy of India by providing employment and supplementing family income. The livestock sector accounts for almost 32 per cent of the agriculture sector contributing 22 per cent of Indian GDP as a whole. In India, the fodder requirement of the existing livestock population of 485 million (Anonymous, 2020) is mostly met through low-quality crop residues and degraded grasslands, which are insufficient for maintaining animal health and productivity. The country at present faces a net deficit of 23.40 percent in dry fodder and 11.24 percent in green fodder (Singh, 2021). In Himachal Pradesh, too, the feed and fodder resources are able to meet the partial requirement of the existing livestock population of 4.41 million (Anonymous, 2020), leaving a vast deficit of 54.03 and 34.37 per cent in green and dry fodder, respectively (Kumar, 2014).

Cite this article: Verma, A., Kumari, P., & Ravinder (2024). Effect of Sowing Methods and Row Spacing on Growth, Yield and Economics of Multicut Sorghum and Pearl Millet Hybrids, *Ind. J. Pure App. Biosci. 12*(3), 58-65. doi: http://dx.doi.org/10.18782/2582-2845.9066

The two obvious approaches to bridge this gap between fodder requirement and availability are either to increase in area under fodder production or to increase the productivity per unit area per unit time under the present scenario of farming of existing production system. Increase in area under fodder crops does not appear feasible because of ever increasing demand of food for human consumption and farmers preference for grain as well as cash crops. Therefore, the second approach i.e.to increase productivity per unit area per unit time, imperatively becomes necessary in the present scenario.

Among cultivated fodder crops, sorghum (*Sorghum bicolour* L.) is an important *Kharif* season crop which gives good biomass in a first cut in most of the cultivars, but the regeneration capacity of this crop is not so good. However, pearl millet (*Pennisetum glaucum* L.) is one of the important millets crop of hot and dry areas of arid and semi-arid climatic condition (Yadav et al., 2018). It has good regeneration capacity after first cut and gives good tonnage in subsequent cuts compared to sorghum. To have more forage yield and better seasonal distribution of the green fodder, the farmers have started to grow newly released sorghum and pearl millet hybrids in combination, due to their differential growth and regeneration behaviour.

Mixed cropping, a predominant feature in the cropping systems, maximises the use of limited farmlands and provides food security to the subsistence farmers (Bhupinder et al., 2003). In a mixed cropping system, the plant arrangement and their densities alter the amount of light transmission to the lower layers of the crops and affect the competition of species for light, water and nutrients (Khalatbari et al., 2009). In mixed cropping, seeds of different crops mixed together, sown in lines or broadcast has important effect on the balance of competition between the component crops and their productivity. The concept of growing more than one crop in combination is to get increased total productivity per unit area and time besides equitable and judicious utilization of land resources and farming inputs. The type of inter/mixed crop and the spatial arrangement of inter/mixed crop have significant effects on the balance of competition between the components of the crop and their productivity.

Sowing methods has an important role in governing the production potential of fodder crops. The sowing methods mostly in fodder crops used are broadcast sowing, drilling or line sowing, dibbling, etc. Out of which broadcast sowing and line sowing are mainly practiced in the country. The superiority of line sowing over broadcast sowing in many crops have been maintained due to the placement of seeds at proper soil depth leading to better yield. Proper row spacing is another important factor in enhancing better-quality fodder yield. Plant competition for environmental resources is affected by the spatial arrangement of plants or the distance between rows. Many researchers have studied the effect of row spacing and sowing methods on fodder production. Afzal et al. (2013) reported maximum improvement in forage yield and quality with drill sowing at 30 cm apart rows as compared to broadcast method. The type of inter/mixed crop and the spatial arrangement of inter/mixed crop have significant effects on the balance of competition between the components of the crop and their productivity. Keeping in view the above facts, the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2022 at the Research Farm of the School of Agriculture, Abhilashi University, Mandi (H.P.) situated at 31° 33´ N latitude and 77° 00´ E longitudes at an elevation of about 1411 meters above mean sea level in north-western Himalayas. Soil of the experimental field was acidic in reaction (5.5), medium in organic carbon (0.72%), low in available nitrogen (238 kg/ha), medium in available

phosphorus (15.52 kg/ha) and available potassium (206 kg/ha). The experiment was laid out in randomized block design with three replications, comprising of nine treatments *i.e.* T_1 - broadcast sowing of sorghum alone, T_2 - line sowing of sorghum alone in 30 cm apart rows, T_3 - line sowing of sorghum alone in 45 cm apart rows, T_4 - broadcast sowing of pearl millet alone, T_5 - line sowing of pearl millet alone in 30 cm apart rows, T_6 - line sowing of pearl millet alone in 45 cm apart rows, T_7 - broadcast sowing of blended seeds (sorghum + pearl millet), T_8 - line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows and T_9 - line sowing of blended seeds (sorghum + pearl millet) in 45 cm apart rows**.** Seeds of 'PHS 111' and 'Kanchan hybrid 115' varieties of sorghum and pearl millet were used for sowing. In sole stand of sorghum and pearl millet, seeds of sorghum and pearl millet using 100 per cent recommended seed rates of sorghum (45 kg/ha) and 100 per cent recommended seed rate of pearl millet (15 kg/ha) sown in lines 30 cm and 45 cm apart as per treatments. In line with the sowing of blended seeds, seeds of sorghum and pearl millet were mixed using 50 per cent recommended seed rates of sorghum (22.5 kg/ha) and 50 per cent recommended seed rate of pearl millet (7.5 kg/ha) and this seed mixture was sown in lines 30 cm and 45 cm apart as per treatments. The experimental plots received a uniform application of a recommended dose of nitrogen, phosphorus and potassium, i.e. 120, 60, 40 kg/ha through urea, single super phosphate and muriate of potash, respectively. Half dose of N, whole of P and K was applied at the time of sowing of crop. The remaining $1/4^{th}$ dose of N was top-dressed after 30 days of sowing of crop and remaining $1/4^{th}$ dose was applied after first cut. The data recorded on various aspects in the present study were subjected to statistical analysis using analysis of variance as per the procedure suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributes

Different treatments significantly affected the growth attributes of fodder sorghum and pearl millet, *viz.*, mean plant height (cm), mean shoot number (per m^2), and total dry matter accumulation (g/m^2) of both cuts (Table 1).

Plant height

In sorghum and pearl millet, the plant height was significantly more under line sowing of sorghum and pearl millet alone in 30 cm apart rows which was statistically at par with line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows, line sowing of sorghum and pearl millet alone in 45 cm apart rows and line sowing of blended seeds of sorghum + pearl millet in 45 cm apart rows. Significantly, minimum heights of sorghum and pearl millet plants were recorded under broadcast sowing of blended seeds of sorghum + pearl millet, which remained at par with the broadcast sowing of sorghum and pearl millet alone. The perusal of data indicated no significant difference in plant height of sorghum and pearl millet between sole stand and blended seeds in line spacing of 30 and 45 cm. Similar results have been reported by Chattha et al. (2017) .Line sowing of sorghum and pearl millet alone or in a mixture resulted in the vigorous growth of plants in terms of plant height due to better sunlight, aeration and other micro-environmental conditions as compared to their broadcast sowing. Ayub and Shoaib (2009) also reported similar results.

Shoot number

A perusal of the data indicated that the shoot number of sorghum and pearl millet was statistically similar whether grown in 30 cm spaced lines or broadcast as a sole stand or in mixture. In sorghum and pearl millet, significantly more number of shoots were obtained with the line sowing of sorghum and pearl millet alone in 30 cm apart rows which remained statistically at par with the broadcast sowing of sorghum and pearl millet alone. Significantly, the lowest sorghum and pearl millet shoot count in their sole stand was

recorded with line sowing in 45 cm apart rows. The data further indicates that the shoot number (m^{-2}) of sorghum and pearl millet was significantly lower with the sowing of their mixture in 50:50 seed proportion either by broadcast or line spacing of 30 and 45 cm as compared to the respective increase in their pure stand. A higher number of shoots per unit area in the sowing of sorghum and pearl millet alone in 30 cm apart rows could be on account of more and uniform distribution of plants per unit area, which resulted in proper utilization of nutrients, water, air and sunlight. Kumpawat (1998) and Hussian et al. (2003) also reported similar results. Line spacing of 45 cm reduced the plant population of sorghum and pearl millet per unit area and thus reduced the number of shoots per square meter.

Dry matter accumulation

Total dry matter accumulation of the two cuts of both crops, *i.e.* sorghum and pearl millet, had a significant effect on the treatments (Table 1). Line sowing of blended sorghum + pearl millet seeds in 30 cm apart rows resulted in significantly higher total dry matter accumulation, which remained statistically at par with the line sowing of pearl millet alone in 30 cm apart rows. The cumulative effect of dry matter accumulation of sorghum and pearl millet at each cut might have reflected its effect on total dry matter accumulation of line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows. Kumar and Ramawat (2006) also observed significantly higher productivity of fodder maize + guinea grass system than sole stand of each crop. Significantly lowest total dry matter accumulation was recorded with broadcast sowing of sorghum alone, which remained at par with the broadcast sowing of pearl millet alone, broadcast sowing of blended seeds of sorghum + pearl millet, as well as line sowing of sorghum alone in 45 cm apart rows.

Yield studies

Green fodder yield

The data on effect of treatments on total green fodder yield (t/ha) of two cuts of sorghum and pearl millet have been presented in the table 2. In sorghum and pearl millet, line sowing of sorghum and pearl millet in 30 cm apart rows resulted in significantly higher total green fodder yield than line sowing of sorghum and pearl millet alone in 45 cm apart rows remaining at par with broadcast sowing of sorghum and pearl millet alone. Total green fodder yield of sorghum and pearl millet decreased significantly with blended sowing of both crops in 50:50 seed proportion either by broadcast or line spacing of 30 and 45 cm, compared to the respective increases in their pure stand.

Total green fodder yield at the first, second and total of the two cuts of both crops, *i.e.* sorghum + pearl millet, had a significant effect on the treatments (Table 4.7). At first cut, blended sowing of sorghum and pearl millet in 30 cm apart rows resulted in significantly higher total green fodder yield (14.40 t/ha) which remained statistically at par with the line sowing of pearl millet in 30 cm apart rows (13.37 t/ha). At the second cut, a significantly higher total green fodder yield (9.69 t/ha) was again recorded with the blended sowing of sorghum and pearl millet in 30 cm apart rows, which remained statistically at par with the line sowing of pearl millet in 30 cm apart rows (9.30 t/ha). Significantly lower total green fodder yield (10.05 t/ha at first cut and 6.89 t/ha at second cut) was recorded with the broadcast sowing of sorghum alone which remained at par with the broadcast sowing of pearl millet alone, broadcast sowing of blended seeds of sorghum and pearl millet and line sowing of sorghum alone in 45 cm apart rows.

The total green fodder yield of the two cuts of both crops *i.e.* sorghum + pearl millet indicated significant superiority of treatments *i.e.* line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows (24.09 t/ha) and line sowing of pearl millet alone in 30 cm

apart rows (22.67 t/ha) remaining at par with each other over rest of the treatments. Perusal of data further indicates that the effect of line sowing of pearl millet alone in 30 cm apart rows was found statistically equal with line sowing of sorghum alone in 30 cm apart rows which further found comparable with line sowing of blended seeds of sorghum + pearl millet in 45 cm apart rows. Treatment, *i.e.* line sowing of blended seeds of sorghum + pearl millet in 45 cm apart rows, further resulted in statistically similar total green fodder yield as of line sowing of pearl millet alone in 45 cm apart. Significantly lower total green fodder yield (16.94 t/ha) was recorded with the broadcast sowing of sorghum alone, which remained at par with the broadcast sowing of pearl millet alone, broadcast sowing of blended seeds of sorghum + pearl millet and line sowing of sorghum alone in 45 cm apart rows.

The herbage yield was obviously the result of better plant height, shoot per meter square and dry matter accumulation (Table 1) of sorghum and pearl millet in the present study. The cumulative effect of all these parameters might have reflected on green fodder yield. Line sowing of sorghum and pearl millet alone or in mixture in 30 and 45 cm apart rows maintained its significant superiority in terms of green fodder yield over broadcast sowing of both the crops alone or in mixture. However, among 30 and 45 cm apart rows of sorghum and pearl millet sown alone or in mixture, higher green fodder yield was recorded with their line sowing in 30 cm apart rows due to higher plant density. Ayub and Shoaib (2009) also reported higher green fodder yield of sorghum in 30 cm apart rows than broadcast sowing of sole sorghum. Line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows provided additional green fodder yield of both the crops thus resulted in 5.89 and 12.25 per cent higher total green fodder yield compared to their sole stand in respective treatments. Ali et al. (2016) also obtained higher total green fodder yield from drill sowing of pearl millet and cluster bean blended seeds in 30 cm apart rows compared to pearl millet and cluster bean sown alone in 30 cm apart rows.

Dry fodder yield

The data on total dry fodder yield (t/ha) of two cuts of sorghum and pearl millet and total dry fodder yield at the first, second and total of the two cuts of both crops, *i.e*. sorghum + pearl milletw as influenced by the different treatments have been given in table 4.3. An examination of the data revealed that the dry fodder yield of sorghum and pearl millet obtained under different treatments was in accordance with green fodder yield obtained in respective treatments.

Economics

Perusal of data indicated a significant effect of treatments on net returns (₹/ha) and net returns per rupee invested (Table 4). Line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows obtained maximum net returns of ₹ 30817 per ha and net returns per rupee invested (1.05), which was statistically at par with line sowing of pearl millet alone in 30 cm apart rows (₹ 28877 per ha and 1.04, respectively). Lowest net returns and net returns per rupee invested were obtained with treatments *i.e.* broadcast sowing of sorghum alone (₹ 13932 per ha and 0.49, respectively) and line sowing of sorghum alone in 45 cm (₹ 15982 per ha and 0.55, respectively) remained at par with each other. The net returns and net returns per rupee invested obtained under different treatments are in conformity with green fodder yield obtained under respective treatments. Higher fodder yield (Table 4.7) in line sowing of sorghum + pearl millet blended seeds in 30 cm apart rows with higher gross returns makes this treatment more profitable. Due to higher herbage yield in treatments comprised of a mixture of sorghum + pearl millet sown by broadcast or line spacing of 30 and 45 cm, the net returns and net returns per rupee invested were better than a respective sole stand of sorghum and pearl millet. Patel et al. (2003) also established better profitability of forage bajra + cowpea intercropping systems.

Table 1: Effect of sowing methods and row spacing on plant height, shoot numbers and total dry matter accumulation (g/m^2) of sorghum and pearl millet

Treatments	Plant height		Shoot number		Total dry matter accumulation (Sorghum + Pearl millet)
	Sorghum	Pearl millet	Sorghum	Pearl millet	
Broadcast sowing of sorghum	86.1	-	71	-	324.39
Line sowing of sorghum alone in 30 cm apart rows	96.2	-	76	-	402.25
Line sowing of sorghum alone in 45 cm apart rows	93.3	-	65	-	351.84
Broadcast sowing of pearl millet	-	97.6	-	79	335.81
Line sowing of pearl millet alone in 30 cm apart rows	-	111.0	-	85	427.68
Line sowing of pearl millet alone in 45 cm apart rows	-	108.2	-	72	372.00
Broadcast sowing of blended seeds (sorghum + pearl millet)	85.3	93.5	40	42	338.54
Line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows	95.4	109.3	46	49	460.38
Line sowing of blended seeds (sorghum + pearl millet) in 45 cm apart rows	92.5	104.6	35	38	390.72
SEm ±	1.02	2.41	1.66	2.00	11.85
CD(P)=0.05	3.08	7.23	5.00	6.00	35.55

Table 2: Effect of sowing methods and row spacing on total green fodder yield (t/ha)

Treatments	Total green fodder yield		Total green fodder yield (Sorghum + Pearl millet)		
	Sorghum	Pearl millet	I Cut	II Cut	Total
Broadcast sowing of sorghum	16.94	-	10.05	6.89	16.94
Line sowing of sorghum alone in 30 cm apart rows	21.14	-	12.61	8.53	21.14
Line sowing of sorghum alone in 45 cm apart rows	18.04	-	10.75	7.29	18.04
Broadcast sowing of pearl millet	-	17.79	10.61	7.18	17.79
Line sowing of pearl millet alone in 30 cm apart rows	-	22.68	13.37	9.30	22.67
Line sowing of pearl millet alone in 45 cm apart rows	-	19.41	11.53	7.88	19.41
Broadcast sowing of blended seeds (sorghum + pearl millet)	7.74	10.31	11.05	7.00	18.05
Line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows	10.62	13.47	14.40	9.69	24.09
Line sowing of blended seeds (sorghum + pearl millet) in 45 cm apart rows	8.48	11.25	11.79	7.94	19.73
SEm ±	0.39	0.55	0.33	0.26	0.53
CD(P)=0.05	1.18	1.67	1.01	0.79	1.59

Table 3: Effect of sowing methods and row spacing on total dry fodder yield (t/ha)

Treatments	Total dry fodder yield		Total dry fodder yield (sorghum + pearl millet)		
	Sorghum	Pearl millet	I Cut	II Cut	Total
Broadcast sowing of sorghum	3.07	-	1.67	1.41	3.07
Line sowing of sorghum alone in 30 cm apart rows	3.85	-	2.11	1.75	3.85
Line sowing of sorghum alone in 45 cm apart rows	3.26	-	1.78	1.48	3.26
Broadcast sowing of pearl millet	-	3.15	1.73	1.42	3.15
Line sowing of pearl millet alone in 30 cm apart rows	-	4.06	2.21	1.85	4.06
Line sowing of pearl millet alone in 45 cm apart rows	-	3.49	1.91	1.58	3.49
Broadcast sowing of blended seeds (sorghum + pearl millet)	1.42	1.78	1.82	1.39	3.20
Line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows	1.97	2.40	2.40	1.97	4.37
Line sowing of blended seeds (sorghum + pearl millet) in 45 cm apart rows	1.58	2.00	1.98	1.61	3.59
SEm ±	0.07	0.08	0.06	0.05	0.10
CD(P)=0.05	0.23	0.26	0.19	0.16	0.30

Table 4: Effect of sowing methods and row spacing on gross returns (₹/ha), net returns (₹ /ha) and net returns per rupee invested

Treatments	Net returns	Net returns per rupee invested
Broadcast sowing of sorghum	13932	0.49
Line sowing of sorghum alone in 30 cm apart rows	21732	0.70
Line sowing of sorghum alone in 45 cm apart rows	15982	0.55
Broadcast sowing of pearl millet	19377	0.77
Line sowing of pearl millet in 30 cm apart rows	28877	1.04
Line sowing of pearl millet in 45 cm apart rows	21947	0.83
Broadcast sowing of blended seeds (sorghum + pearl millet)	18417	0.69
Line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows	30817	1.05
Line sowing of blended seeds (sorghum + pearl millet) in 45 cm apart rows	21527	0.77
SEm±	740	0.01
CD (P = 0.05)	2222	0.03

CONCLUSION

Line sowing of blended seeds of sorghum + pearl millet in 30 cm apart rows proved better from a production and profit point of view. Line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows produced higher total green and dry fodder yields. Line sowing of blended seeds (sorghum + pearl millet) in 30 cm apart rows proved advantageous in terms of net returns and net returns per rupee invested. The next best treatment *w.r.t.* herbage yield and monetary returns was line sowing of sole pearl millet in 30 cm apart rows.

Acknowledgement:
The authors are thankful to Abhilashi University, Mandi (H.P.), for providing the facility to conduct the experimental trials.

Funding: Nil

Conflict of Interest: None

Authors' Contribution: All the authors are directly involved in this survey work, and supervisors are constantly monitor the progress of this field study and contribute their thoughts.

REFERENCES

Afzal, M., Ahmad, A. H. U., Zamir, S. I., Khalid., F., Mohsin, A. U., & Gillani, S. M. W. (2013). Performance of multicut forage sorghum under various sowing methods and nitrogen application rates. *The Journal of Animal & Plant Sciences 23*(1), 232-239.

Anonymous (2020). Epidemiology of brucellosis in India: a review. *Pantnagar Journal of Research. 17*(3), 199-205

Ali, M. A., Khan, F. H., Ali, R. S., Afzal, Z., Saleem, M. T., & Azeem, M. (2016). Effect of intercropping of pearl millet and cluster bean on forage quality and quantity. *Journal of Entomology and Zoology Studies 4*(6), 397-400.

Ayub, M., & Shoaib, M. (2009). Studies on fodder yield and quality of sorghum grown alone and in mixture with guara under different planting techniques. *Pakistan Journal of Agricultural Science 46*(1), 25-29.

Bhupinder, S., Kalidindi, U., Singh, B., & Usha, K. (2003). Nodulation and symbiotic nitrogen fixation of cowpea genotypes as affected by fertilizer nitrogen. *Journal of Plant Nutrition 26*(2), 463-473.

Chattha, M. U., Iqbal, A., Hassan, M. U., Chattha, M. B., Ishaque, W., Usman, M., Khan, S., Fayyaz, M. T., & Ullah, M. A. (2017). Forage yield and quality

of sweet sorghum as influenced by sowing methods and harvesting times. *Journal of Basic & Applied Sciences 13*(6), 301-306.

Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedure for Agricultural Research. 2nd edition Wiley Inter Science, New York, USA. p 680.

Hussain, N., Shamsi, I. H., Khan, S., Akber, H., & Shah, A. W. (2003). Effect of legume intercrops and nitrogen levels on the yield performance of maize. *Asian Journal of Plant Science 2*(2), 242-246.

Khalatbari, A. M., Hosseini, M. B., Khalatbari, A. A., Zandvakili, O. R., & Eslampour, A. H. (2009). Evaluation of intercropping forage sorghum with pearl millet at different row proportion and plant density in semi arid areas. *Advances in Environmental Biology 3*(1), 15-20.

Kumar, N., & Ramawat, N. (2006). Production potential and economics of maize (*Zea mays*) + guinea grass (*Panicum maxicum*) cropping in different proportions under subtropical conditions. *Forage Research 32*(3), 159-162.

Kumar, N. (2014). QRT Report. All India Co-ordinated Research project on Forage Crops. CSK HPKV, Palampur (HP).

Kumpawat, B. S. (1998). Response of late-sown wheat (*Triticum aestivum*) to sowing method and seed rate. *Indian Journal of Agronomy 43*(4), 650-652.

Singh, R. (2020). Role of livestock in India economy, Department of veterinary public health and epidemiology Uttarakhand, India.

Yadav, L. C., Yadav, L. R., Yadav, N., & Yadav, M. (2018). Effect of organic sources of nitrogen fertilization on growth and yield of pearl millet [*Pennisetum Glaucum* (L.)]. *International journal of Chemical Studies 6*(3), 2329-2331.